A Beginning Toward Understanding Phosphorus Irons

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ABSTRACT

In the early 1970's when phosphorus irons became of interest, a problem regarding ductility of these alloys was recognized, however it was reported that the problem could not occur in production owing to slower cooling rates.

It is true that alloys containing 0.45% phosphorus are only slightly less ductile than pure iron, however when 0.8% or more phosphorus is alloyed, ductility markedly decreases. In fact, elongation is often only 1%. If subsequent cold deformation is required, these alloys are brittle and the user must compromise magnetic properties for ductility by restricting usage to the 0.45% phosphorus iron.

The work reported in this study does not provide a solution to resolve the embrittlement of 0.8% phosphorus iron. The work offers some observations that pinpoint the cause of the embrittlement. Understanding of the reasons for embrittlement permit models or solutions to evolve that may minimize the problem. Some ideas for solutions will be offered.

INTRODUCTION

In the mid 1970's the development of a commercial high purity, high compressibility, water atomized iron powder, and the introduction of commercial ferrophosphorus intermetallics for alloying with the iron powders, made P/M technology suitable for magnetic applications.

Subsequent developments have permitted the introduction of phosphorus iron parts that could successfully compete in the magnetic market with existing wrought alloys. Since then improvements in powders and sintering techniques have resulted in the selection of improved P/M phosphorus irons for new electric designs emerging from the drawing boards. Data on the magnetic properties of these alloys has become available to assist designers in employing these newer high quality P/M alloys. In fact, recently predictor equations have been modified to reflect more recent improvements in sintering practice.(1)

Many magnetic components must also be cold deformed to mate with component